

Claims

- [c1] A pipe coupling assembly comprising:
- a first pipe section comprising a first coupling member located at an end of said first pipe section, said first coupling member comprising a cylindrical flange and a spherical convex seat portion, said flange comprising a first plurality of pivot notches;
 - a second pipe section comprising a second coupling member located at an end of said second pipe section, said second coupling member comprising a cylindrical flange and a spherical concave seat portion, said flange comprising a second plurality of pivot notches, said concave seat portion configured to receive said first convex seat portion; and
 - a first and a second cylindrical spring ring, each said spring ring comprising:
 - a body having a first surface and an opposing second surface, said body comprising a main bore and a plurality of bolt bores extending therethrough, said main bore configured to receive a pipe section therethrough, said bolt bore configured to receive a fastener therethrough;
 - a plurality of pivot bearings extending from said first surface, each said pivot bearing configured to engage a pipe section flange notch; and
 - a plurality of bolt bore seats located in said second surface and coaxially aligned with said bolt bores, each said bolt bore seat configured to receive a first portion of a fastener.
- [c2] A pipe coupling assembly in accordance with Claim 1 wherein each said pivot bearing is substantially adjacent a respective bolt bore.
- [c3] A pipe coupling assembly in accordance with Claim 1 wherein a bolt extends through each said first and said second spring ring bolt bores to couple said first coupling member to said second coupling member.
- [c4] A pipe coupling assembly in accordance with Claim 3 wherein each said bolt comprises a spherical bearing at each end, said spherical bearings sized to mate with a bolt bore spherical seat.
- [c5] A pipe coupling assembly in accordance with Claim 1 wherein said bolt bores have a diameter larger than a diameter of said bolts.

- [c6] A pipe coupling assembly in accordance with Claim 3 wherein each said bolt further comprises a crimp nut to prevent loosening of said bolt.
- [c7] A coupling spring ring for coupling a first pipe section flange to second pipe section flange in a nuclear reactor, each flange comprising at least one notch, said spring ring comprising:
 - a body having a first surface and an opposing second surface, said body comprising a main bore and a plurality of bolt bores extending therethrough, said main bore configured to receive a pipe section therethrough, said bolt bore configured to receive a fastener therethrough;
 - a plurality of pivot bearings extending from said first surface, each said pivot bearing configured to engage a pipe section flange notch; and
 - a plurality of bolt bore seats located in said second surface and coaxially aligned with said bolt bores.
- [c8] A spring ring in accordance with Claim 7 wherein said spring ring is substantially cylindrical.
- [c9] A spring ring in accordance with Claim 7 wherein said plurality of pivot bearings are equally spaced circumferentially around said spring ring first surface.
- [c10] A spring ring in accordance with Claim 7 wherein said plurality of bolt bore seats are substantially spherical.
- [c11] A spring ring in accordance with Claim 10 further comprising a bolt extending through each bolt bore, each said bolt comprising at least one spherical bearing sized to mate with a bolt bore seat.
- [c12] A method of joining two pipe sections in a nuclear reactor, a first pipe section comprises a first coupling member located at an end of the first pipe section, the first coupling member comprising a cylindrical flange and a spherical convex seat portion, the flange comprising a first plurality of pivot notches, a second pipe section comprising a second coupling member located at an end of the second pipe section, the second coupling member comprising a cylindrical flange and a spherical concave seat portion, the flange comprising a second plurality of pivot notches, the concave seat portion configured to receive the

first convex seat portion, said method comprising:
seating a first spring ring on the first pipe section;
seating a second spring ring on the second pipe section; and
coupling the first spring ring to the second spring ring with at least two bolts,
each spring ring comprising:
a body having a first surface and an opposing second surface, the body
comprising a main bore and a plurality of bolt bores extending therethrough,
the main bore configured to receive a pipe section therethrough, the bolt bore
configured to receive a bolt therethrough;
a plurality of pivot bearings extending from the first surface, each pivot bearing
configured to engage a pipe section flange notch; and
a plurality of bolt bore seats located in the second surface and coaxially aligned
with the bolt bores, each bolt bore seat configured to receive a first portion of a
fastener.

- [c13] A method in accordance with Claim 12 further comprising seating the first pipe section convex seat portion on the second pipe section concave seat portion.
- [c14] A method in accordance with Claim 13 wherein seating the first spring ring on the first pipe section flange comprises seating the first spring ring on the first pipe section flange with each pivot bearing of the first spring ring engaging a pivot notch of the first pipe section flange.
- [c15] A method in accordance with Claim 14 wherein seating the second spring ring on the second pipe section flange comprises seating the second spring ring on the second pipe section flange with each pivot bearing of the second spring ring engaging a pivot notch of the second pipe section flange.
- [c16] A method in accordance with Claim 15 further comprising coaxially aligning each first spring ring bolt bore with a corresponding second spring ring bolt bore.
- [c17] A method in accordance with Claim 15 wherein coupling the first and second spring rings comprises securing a bolt through each first spring ring bolt bore and the corresponding second spring ring bolt bore to couple the first and

second coupling members.

- [c18] A method in accordance with Claim 17 wherein each bolt bore seat is substantially spherical and each bolt comprises at least one spherical bearing sized to mate with a bolt bore seat.
- [c19] A method in accordance with Claim 17 further comprising applying a pre-load to the bolts.
- [c20] A method in accordance with Claim 19 wherein coupling said first and second spring rings further comprises coupling at least one locking mechanism to each fastener.

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